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# CHAPTER 1: INTRODUCTION

## DOCUMENT PURPOSE

This document provides flow recommendations for the San Juan River of New Mexico, Colorado, and Utah designed to conserve and recover two endangered fishes, Colorado pikeminnow (*Ptychocheilus lucius*) and razorback sucker (*Xyrauchen texanus*). It is based on information gathered on the San Juan River during a 7-year research effort funded largely by the Bureau of Reclamation (Bureau) and the Bureau of Indian Affairs (BIA), although additional information related to the fish species of interest has been gathered from literature sources. The flow recommendations made in this report may be changed in the future, in response to new information, through an adaptive management process. A monitoring program is being developed that will evaluate the success of the flow recommendations and other actions that may be implemented to aid in recovery of the two endangered fish species.

The San Juan River Basin Recovery Implementation Program (SJRIP) was initiated in 1992 with the following two goals:

1. To conserve populations of Colorado pikeminnow and razorback sucker in the basin, consistent with the recovery goals established under the Endangered Species Act, 16 U.S.C. 1531 et seq.
2. To proceed with water development in the basin in compliance with federal and state laws, interstate compacts, Supreme Court decrees, and federal trust responsibilities to the Southern Utes, Ute Mountain Utes, Jicarillas, and the Navajos.

Emphasis within the SJRIP has been placed on identifying limiting factors and implementing actions to meet the environmental needs of the endangered fish species. Ongoing and proposed activities under the SJRIP include reregulation of flows from Navajo Dam to better meet species needs, control of nonnative fishes, propagation of target species, and identification and removal of fish-passage barriers.

The Colorado pikeminnow and razorback sucker were widespread and apparently abundant throughout much of the Upper Colorado River Basin (Upper Basin), including the San Juan River, during the settlement and initial development of the western United States (circa 1870s to 1950s) (Jordan 1891, Koster 1957, Quartarone 1993, Stanford 1994). Jordan (1891) noted that settlers reported both species upstream as far as Durango, Colorado, in the San Juan River system, and three juvenile Colorado pikeminnow were collected in 1936 in the portion of the river now inundated by Lake Powell (Platania 1990). Several other adult and juvenile Colorado pikeminnow were collected

in the river during the mid-20th Century, but no thorough fish collecting studies were conducted on the San Juan River until 1978, well after Navajo Dam was completed. VTN Consolidated, Inc. and the Museum of Northern Arizona (1978) sampled the river from near Navajo Dam to Lake Powell in 1978 and collected one juvenile Colorado pikeminnow and reported (second hand) the occurrence of razorback sucker in that reach of river, suggesting that neither species was abundant in the system at that time. Current population size of these fish species is greatly reduced, and recruitment is limited throughout the Upper Basin, including the San Juan River. Decline of the endangered Colorado pikeminnow and razorback sucker in the Upper Basin and San Juan River has been attributed to habitat fragmentation and loss, alteration of historical flow regimes, and other environmental changes associated with the construction and operation of reservoirs. Contaminants, eradication of native fish and stocking of nonnatives as sportfish management activities, and predation and competition by introduced fishes have also been implicated in the decline of the Colorado pikeminnow and razorback sucker (Tyus 1991a, Minckley et al. 1991, USFWS 1997).

In 1987, a 3-year research effort concentrating on the two endangered species was initiated in the San Juan River by the U.S. Fish and Wildlife Service (USFWS), Bureau, New Mexico Department of Game and Fish (NMGF), and Utah Division of Wildlife Resources (UDWR). The study found a number of young and adult Colorado pikeminnow and an adult razorback sucker, confirming that both species still inhabited the San Juan River but apparently in relatively small numbers. These findings prompted reinitiation of Section 7 Consultation (Consultation) on major proposed water projects on the San Juan River. Consultation on the Animas-La Plata Project (ALP) in 1991 resulted in the Bureau agreeing to reoperate Navajo Dam and fund approximately 7 years of research on the San Juan River to study the effect of flow changes. Following Consultation on the Navajo Indian Irrigation Project (NIIP) in 1991, the BIA agreed to assist with funding and to participate in the 7-year research effort. This 7-year research effort was incorporated into the research requirements of the SJRIP when it was formed, and the research has been carried out by a multiagency group including the USFWS, NMGF, Bureau, BIA, UDWR, Bureau of Land Management (BLM), National Park Service, Southern Ute Tribe, Jicarilla-Apache Tribe, Navajo Nation, University of New Mexico, and other organizations.

A major milestone identified for the SJRIP was the development of flow recommendations for the endangered fish species. This milestone was formalized in the Long Range Plan (LRP) in 1995, a document detailing the proposed recovery effort including time lines, budgets, and milestones. Milestone 5.2.7 of the LRP states, "Identify, recommend and implement flows designed to maximize and maintain suitable habitats for all life stages of endangered and other native fish species." The LRP also includes milestones for other potential limiting factors, such as the effects of nonnative species and contaminants. Since flow recommendations were very important to all participants in the SJRIP and their development involved many detailed analyses, they were developed first. This report restricts itself to the issue of flow needs and does not discuss in detail other potential limiting factors. Discussions of other potential limiting factors will be presented in a companion document scheduled for completion in 1999.

Prior to Navajo Dam's regulation of the San Juan River in 1962, flows were highly variable and dominated by the spring snowmelt runoff. Pre-dam (1929 to 1961) mean monthly flows at Shiprock, New Mexico, ranged from a low of 44 cubic feet per second (cfs) in September 1956 to a high of 19,790 cfs in May 1941. Since the closure of Navajo Dam, flows in the San Juan River have been significantly altered by operations that typically store water during the spring runoff and release storage during the summer, fall, and winter months. Peak spring flows at Bluff, Utah, have been decreased by approximately 45%, while the average winter low flow has approximately doubled.

Additional depletions and redistribution of flows have occurred as a result of other large water development projects, including the NIIP and the San Juan-Chama Project. At the current level of development, the average annual flow volume at Bluff has been depleted by approximately 30% (USFWS 1996). Future proposed projects could significantly increase depletions in the basin.

In order to meet the objectives of the SJRIP, and especially Milestone 5.2.7. of the LRP, a number of studies were initiated by the SJRIP with the intent of providing a flow recommendation by 1998. The general plan for these studies was to alter Navajo Dam operations so that resulting flows below the mouth of the Animas River, a major tributary entering the San Juan River about 45 miles (mi) below the dam, would mimic a natural hydrograph. This mimicry primarily related to flow pattern and timing, including a spring runoff peak and low late summer and fall base flows, the primary components of the natural hydrograph altered by Navajo Dam. Consideration was also given to year-to-year variations in size of runoff that reflected the actual runoff conditions of that year in the San Juan Basin. Physical and biological studies were designed to evaluate the response of the aquatic system to these "research flows." Stanford (1994), in a review of studies from other portions of the Upper Basin, suggested that a healthy native fish community is needed for recovery of the endangered species. San Juan River studies emphasized the entire fish community, especially the native fish community, rather than concentrating on only the two endangered species. The physical studies concentrated on learning how the river functioned, especially in relation to formation and maintenance of habitats that were important to the native fish community. This involved intensive studies on the river's hydrology and geomorphology as well as development of a method to measure habitat at various flow levels.

This report is an integration of flow-related portions of various individual projects that were initiated as part of the SJRIP 7-year research plan. The purpose of this report is to provide initial flow recommendations for the San Juan River that promote the recovery of the endangered Colorado pikeminnow and razorback sucker, maintain important habitat for these two species as well as the other native species, and allow the evaluation of continued water development potential in the basin in light of the recommended flows. In addition, this report contains recommendations for Navajo Dam operations to meet the flow recommendations and fulfill commitments made as part of the ALP and NIIP Biological Opinions.

Specific objectives for this report include:

- C Identify the range of flows (annual and seasonal) that will promote the recovery of endangered Colorado pikeminnow and razorback sucker in the San Juan River.
- C Make recommendations for Navajo Dam operations to meet recommended flows that take into account the hydrology of the system, the physical capacities of Navajo Dam, and other institutional requirements.

The flow recommendations discussed in this report are considered an initiation of a process, rather than numbers that are “fixed in stone.” These recommendations may be refined in the future as new information becomes available. The flows recommended in this report are based on the best knowledge of the San Juan River system at the time the report was being prepared. As new knowledge is gained and new management actions are taken, the evaluation of that information will be used to refine the recommendations. This refinement is part of an adaptive management process that will continually update the assumptions and models used to develop these flow recommendations.

Determination of flow requirements for aquatic ecosystem protection is an evolving science. During the 1960s and early 1970s, research concentrated on identifying minimum flows necessary to maintain the minimum habitat necessary to sustain a particular target species. In the 1970s the research progressed to examining flow/habitat relationships, thus quantifying habitat conditions over a range of flows with the ability to optimize habitat availability. Tools such as the Physical Habitat Simulation System (PHABSIM) and the Instream Flow Incremental Method (IFIM) were developed as a result of this work (Stalnaker et al. 1995).

Researchers now recognize the limitations of these habitat models and the need to more clearly define the processes that form important habitats, in addition to the potential range of flow conditions needed to maintain them (Osmundson et al. 1995). A goal stated by researchers working with IFIM is to identify new methods of determining flow requirements that include the link between flow events (floods or droughts) in preceding years upon habitat availability in the current year (Stalnaker et al. 1995).

More recently, studies are focusing on the importance of the natural flow regime, recognizing that temporal (intra- and interannual) flow variability is necessary to create and maintain habitat and to maintain a healthy biological community in the long term. The processes that link hydrology, geomorphology, habitat, and fish species are being recognized as important, yet these relationships are not always well understood. Recent literature suggests that restoring a more natural hydrograph by mimicking the variability in flow that existed before human intervention provides the best conditions to protect natural biological variability and health (McBain & Trush 1997, Williams et al. 1997, Poff et al. 1998, Richter et al. 1998).

Mimicry of the natural hydrograph is the foundation of the flow recommendation process for the San Juan River. The linkages between hydrology, geomorphology, habitat, and biology were used to define mimicry in terms of flow magnitude, duration, and frequency for the runoff and base-flow periods. The flow characteristics of these linkages were compared with the statistics of the pre-Navajo Dam hydrology to assist in fine-tuning the recommendations. The flow/geomorphology relationship, based on the examination of historical changes in flow regimes and 7 years of research emphasizing the channel's response to specific flow conditions, was a major component of this process. The geomorphology/habitat relationship was examined for the key habitat conditions appearing to be most at risk in the system or the most critical to the species. These relationships relate to the creation and maintenance of the particular habitats used by the rare fish. The flow/habitat availability relationship, once the habitats are created and maintained, was also identified and included in the flow recommendation process. A major step used to develop flow recommendations was identification of habitats important to the various life stages of each species studied and relating that information to the availability of those important habitats under differing flow scenarios. This step is critical to the identification of the most important or most limiting habitats, since those habitats become the primary focus of the flow recommendations. Finally, the direct response of the species studied to research flows was included to identify biological responses that may not be directly addressed in the relationships linking physical and biological processes.

While the San Juan River studies completed over the last 7 years do not answer all of the key questions on biological responses to flows and the linkages described, the studies do demonstrate the importance of maintaining a naturally shaped hydrograph and providing flow variability from year-to-year. In addition, certain durations and frequencies of specific flow magnitudes in the range of 500 to 10,000 cfs are identified as having particular importance in the creation and maintenance of geomorphological features and habitat that are both important to the species and provide a positive response in at least some of the native fish community. A reservoir operation process is recommended that will maintain the specified conditions and preserve the natural flow variability.

Section 5.7 of the LRP states "Implement and maintain an adaptive management program to ensure conduct of appropriate research and management activities to attain and maintain recovery of endangered fish species." "Adaptive management" is a process where lessons learned are used to adjust and refine an ongoing process. The SJRIP uses this process in its research and management activities. For example, the stocking of endangered fish was not envisioned in the LRP until 1997 or later, but actual stocking was initiated in 1994 when it became clear that existing population levels in the San Juan River system were too low to measure responses. It is anticipated that continued annual monitoring and assessment of the fish community's response to the flow recommendations will be used to adjust the flow recommendations in the future, according to this adaptive management program. It is important to recognize that continued monitoring is necessary, and future adjustment to the flow recommendations is likely, as more is understood about the processes and the response of the fishes to the restored hydrologic regime. The ability to adaptively manage the system is important because flow recommendations can be refined in response to the emerging understanding of the mechanisms involved in recovery of the endangered species in the San Juan River.

This report is one of two reports that address the results of the 7-year research program. This report focuses on the analysis and integration of biological, hydrologic, and geomorphic data to determine flow needs of the endangered fishes. A companion report, to be produced in 1999, will compile and synthesize all results from the 7-year research program not covered in this document. The companion report will also specifically address issues such as contaminants, propagation, nonnative species control, and fish-passage needs.

## **DOCUMENT ORGANIZATION**

Chapters 2 and 3 of this document summarize background information concerning the physical and biological aspects of the SJRIP study area (study area). This summary primarily includes a review of river conditions pre- and post-Navajo Dam, and important life history aspects of the San Juan River fish community. Chapter 4, the major chapter of the document, describes the results of various studies conducted during the 7-year research period as they relate to flow recommendations. This chapter includes information on the research flows that were produced by reoperation of Navajo Dam, how those flows affected river geomorphology and fish habitat, and how the fish community responded to the flows. The biological basis for the flow recommendations is also discussed in Chapter 4.

Chapter 5 is a brief review of contaminants and water quality in the San Juan River. Chapter 6 summarizes the pertinent information found in Chapters 2, 3, 4, and 5 that formed the basis for the flow recommendations. Chapter 7 describes the modeling process that was used to turn the biological and physical information utilized in developing flow recommendations into a process that can be used to determine when flow recommendations are met and what level of water development may still be available in the basin. Chapter 8 presents the flow recommendations, summarizes modeling results, and provides a set of Navajo Dam operating rules for meeting the flow recommendations. Appendix A is a response to comments from the Peer Review Panel and SJRIP Coordination Committee on the December 4, 1998, draft of this report. Some of the responses resulted in changes that are reflected in this final version of the report, and others were most appropriately answered separately.

Throughout the document, English equivalents are used for most measures, although some common metric equivalents are also used. For example, fish measurements are typically made in millimeters (mm) and this report follows that fashion. However, the river was divided into River Miles (RM), and flows are typically described in terms of cfs, or acre-feet (af), so these English conventions were followed to make the document more understandable to the majority of the target audience.